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ABSTRACT

Critical thinking comprises the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts. The study of critical thinking combines the educational, philosophical, and psychological traditions of thought. R. Ennis offers a philosophical taxonomy suggesting that critical thinking results from the interaction of a set of dispositions toward critical thinking with a set of abilities for critical thinking, while R. Sternberg's psychological taxonomy defines the skills involved in critical thinking to be of three kinds: metacomponents, performance components, and knowledge-acquisition components. Bloom's taxonomy of education puts knowledge at the lowest level, followed by comprehension, application, analysis, and synthesis, with evaluation at the highest level. Tests for measuring critical thinking also come from the philosophical and psychological areas. The Watson-Glaser Critical Thinking Appraisal, the Cornell Critical Thinking Test, and the New Jersey Test of Reasoning Skills are derived from the philosophical tradition. The Triarchic Test of Intellectual Skills is psychologically derived, but does not try to separate critical thinking from intelligence. Programs for training critical thinking include Copi's 1978 course in logic, Bransford and Stein's 1984 course called "The Ideal Problem Solver," Sternberg's 1986 "Understanding and Increasing Intelligence," and Whimbey and Lochhead's 1982 "Problem Solving and Comprehension." Educators current concern with critical thinking offers students a new chance for developing critical thinking skills, but training must be brought into all aspects of the classroom to be successful. (Tables outlining E.J. Gubbins's Matrix of Thinking Skills, and Sternberg's program for training intellectual skills are appended.) (SRT)

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Critical Thinking: Its Nature, Measurement, and Improvement

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Critical Thinking: Its Nature, Measurement, and Improvement

More than a decade has passed since then-President John F. Kennedy ordered the invasion of the Bay of Pigs. The invasion was to become one of the great disasters in U.S. political and military history. The invasion did not, of course, succeed in the ultimate overthrow of Cuba's Fidel Castro. More interestingly, there is a widespread consensus among students of the situation that the invasion never had a chance to succeed in the first place. The decision to invade, made largely by Ivy-League educated men with some experience in political affairs, represented what from almost any point of view would have to be labeled as a lapse in critical thinking.

What is critical thinking, and how can well-educated men and women show lapses in it that are serious enough to lead to fiascos such as the Bay of Pigs, the Watergate break-in and coverup, and any of a number of other such similar events in our country's history? The goal of this article is to define critical thinking, to review alternative approaches to understanding it, to compare some alternative procedures for measuring it, and to discuss some alternative attempts to train it.

A Definition of Critical Thinking

Construed broadly, critical thinking comprises the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts. The particular elements of critical thinking that people use vary widely both in scope and in quality across persons, tasks, and situations. Hence, it is necessary to specify in some detail just what the elements of critical thinking are, and how they vary across persons, tasks, and situations. Such a specification is the goal of the next section of this article.

Theories of the Nature of Critical Thinking

In some fields of educational endeavor, it is difficult to get educational theorists to agree about anything. The field of critical thinking is distinctive for its amount of consensus among theoriests regarding the nature of critical thinking. This is not to say that the consensus is complete, or that alternative theories and approaches to theorizing are nonexistent. It is to say, however, that the agreements clearly outweigh the disagreements. A review of theories and approaches suggests that the major differences are in how broadly or narrowly the construct of critical thinking is viewed--in its boundaries--rather than in what is viewed to be the core.

Three Traditions of Theorizing

The study of critical thinking is of particular interest because of its confluence of three traditions of thought--the educational, the philosophical, and the psychological. Indeed, if there is a modern-day founder of the "critical-thinking movement," it is almost certainly John Dewey, who was simultaneously an educator, a philosopher, and a psychologist.

The philosophical tradition. The concern of philosophers with the elements of critical thinking dates back to ancient times. If Dewey is the modern-day founder of the critical-thinking movement, then Plato and Aristotle would be its ancient founders. In more recent times, philosophers such as Ennis (in press), Lipman (in press), and Paul (in press) have devoted their attention to understanding the bases of critical thinking.

Philosophers have focused their attention not so much upon the requirements of critical thinking in the classroom, but upon the requirements of formal logical systems. The difference in emphasis is important for two reasons.

First, the requirements of formal logical systems do not necessarily correspond to the requirements or capabilities of children in classroom situations. Indeed, the two sets of requirements may be completely different. For example, "resolution logic" provides a powerful method for proving certain logical theorems, but probably no one (in their right mind!) would claim that children spontaneously use resolution logic, or even that many of them would spontaneously adopt it after anything but extensive training. Not all philosophers have been quick to recognize the difference between the laws of logic and the laws of thought. Indeed, Boole (1954) entitled his book on "Boolean logic," The Laws of Thought, despite the fact that there is no evidence at all that people spontaneously adopt these laws in their thought.

Second, the requirements of logical systems may perhaps better be thought of as providing models of competence rather than models of performance for human thought. The rules of logic can tell us how people might think critically under ideal circumstances in which the limitations typically placed upon the human information processing system are not in place. But there are numerous potential limitations that ordinarily block the utilization of our full competence--limited time, limited information, limited working memory capacity, limited motivation, and so on.

These two delimitations on the interpretation of philosophical theories are not criticisms of philosophical approaches. We need to know the maximum potentials of critical thought, lest we settle for less precision and reflectivity in our thinking than that of which we are capable. At the same time, we need to recognize the personal and situational constraints that often impinge upon our working up to full capacity.

The psychological tradition. Psychologists interested in the nature of critical thinking, such as Bransford (1984), Bruner (1960, 1961), Feuerstein (1980), and Sternberg (1985), have been particularly concerned with characterizing critical thinking as it is performed under the limitations of the person and the environment. For example, Feuerstein (1980) has specified how the critical thinking of retarded performers differs from that of normal performers; Sternberg and Davidson (1983), in contrast, compared the critical thinking of gifted and normal performers. None of these theorists, though, has proposed a model of totally rational thinking. Indeed, Guyote and Sternberg's (1981) work is more typical of psychological theorizing in pinpointing how people differ from the fully rational performer in solving syllogisms.

Psychological theorizing can be valuable in showing how people think critically in the absence of full information, unlimited time, perfect memory, and so on. At the same time, it is necessary to observe two cautions in evaluating the theories of many psychologists.

First, the theories of psychologists are often derived from and tested on performance of human subjects in laboratory settings, and there is no guarantee that people will perform in their everyday lives and especially in the classroom in the same ways that they do in the laboratory. To the contrary, most available evidence suggests consequential differences in the two kinds of settings of performance.

Second, the constraints of proposing theories that are empirically testable through the standard means of psychological experimentation sometimes results in theories that oversimplify the analysis of critical thinking. The constraint of testability contributes to scientific analysis but often at the expense of oversimplification.

The educational tradition. In the educational tradition of theorizing are leading figures such as Bloom (1956), Gagne (1965), Perkins (1981), and Renzulli (1976), whose theorizing seems directly responsive to the skills needed by children in the classroom for problem solving, decision making, and concept learning. Bloom's (1956) famous taxonomy of cognitive skills and Gagne's (1965) well-known hierarchy of learning skills have seen widespread application in classroom situations and even textbook creation. These theorists have drawn heavily upon classroom observation, text analysis, and process analysis of thinking in the classroom to guide their thinking about critical thinking.

Educational theories have the advantage of being closely tied to classroom observation and experience. At the same time, there are two points to keep in mind when using or evaluating these theories.

First, the educational theories often do not have the clarity in epistemological status that is characteristic of the philosophical and psychological theories, making it more difficult, in some respects, both to evaluate and to use the educational theories. Philosophical theories tend to be competence theories specifying what people can do; psychological theories tend to be performance theories specifying what people actually do; educational theories are often a mixture of the two, with the nature and proportions of the mix less than clearly specified. To this day, for example, educators argue over the extent to which Bloom's taxonomy represents a prescriptive versus a descriptive model of human thought.

Second, in my experience, educationally-based theories tend not to have been subjected to tests of the same degree of rigor that has characterized the testing of philosophical and psychological theories.

Philosophical theories based on various kinds of logics must be logically rigorous and internally consistent. Psychological theories based on human performance must be externally consistent with respect to the behavior they purport to describe. Educational theories are often not subjected either to the logical tests of philosophical theories or to the psychological tests of the psychological theories.

A Framework for Theories of the Nature of Critical Thinking

Because there are so many accounts of critical thinking, and because they so often say similar things in different ways, or even occasionally different things in similar ways, it becomes important to develop some kind of framework that can encompass the various theories, and highlight their similarities and differences.

The framework proposed here is based upon that generated by my triarchic theory of human intelligence (Sternberg, 1985). The framework was derived in large part by classifying the goals and scope of many previous theories of intellectual functioning. In the present context, it is proposed that theories of critical thinking can, and often do deal with one or more aspects of critical thinking--its relation to the mind of the individual, its relation to the context in which it occurs, and its relation to the experience of the individual with various kinds of tasks and situations previously confronted that required critical thinking in greater or lesser degree.

The relation of critical thinking to the internal world of the individual. Theories of the internal workings of the mind when it engages in critical thinking can be seen as being aimed at the very essence of what critical thinking is about: What do we do when we think critically, and how do we do it?

Students of critical thinking have proposed various taxonomies of skills purported to span the range of critical thinking. Consider three examples of such taxonomies, one each from the philosophical, psychological, and educational traditions.

1. A philosophical taxonomy: Robert Ennis (in press). Ennis, a philosopher, has suggested that critical thinking results from the interaction of a set of dispositions toward critical thinking with a set of abilities for critical thinking.

The dispositions include, among others, (a) seeking a clear statement of the thesis or question, (b) seeking reasons, (c) trying to be well-informed, and (d) trying to remain relevant to the main point. The idea underlying the listing of dispositions is that a prerequisite for critical thinking is the motivation or desire to think critically.

Ennis classifies abilities under five main categories, which are themselves further subdivided. The categories are elementary clarification, basic support, inference, advanced clarification, and strategy and tactics.

Elementary clarification consists of focusing on a question, analyzing arguments, and asking and answering questions of clarification and/or challenge. Basic support involves judging the credibility of a source and observing and judging observation reports. Inference comprises deducing and judging deductions, inducing and judging inductions, and making and judging value judgments. Advanced clarification involves defining terms and judging definitions, and identifying assumptions. Finally, strategy and tactics include deciding on an action and interacting with others. These categories are all themselves further subdivided (see Ennis, in press).

2. A psychological taxonomy: Robert Sternberg (1985). My own taxonomy derives not from a logical but from a psychological analysis of critical thinking. According to my own "componential" account of thought, the skills involved in critical thinking are of three kinds: metacomponents, performance components, and knowledge-acquisition components.

Metacomponents are higher order executive processes used to plan what one is going to do, monitor it while one is doing it, and evaluate it after it is done. The metacomponents include recognizing that a problem exists, defining the nature of the problem, deciding on a set of steps for solving the problem, ordering these steps into a coherent strategy, deciding upon a form of mental representation for information, allocating one's time and resources in solving a problem, monitoring one's solution to a problem as the problem is being solved, and utilizing feedback regarding problem solving after one's problem solving has been completed. Similar taxonomies have been proposed by Brown (1978) and Bransford (1984).

Performance components are lower order, nonexecutive processes used to execute the instructions of the metacomponents, and provide feedback to them. Performance components vary by domain of performance, for example, inductive reasoning, deductive reasoning, spatial visualization, reading, and so on. Consider, for example, the performance components of induction. These include encoding stimuli, comparing stimuli, inferring relations between stimuli, mapping relations between relations, applying relations from one domain to another, justifying potential repsonses, and responding.

Knowledge-acquisition components are the processes used to learn concepts or procedures. Three such components are selective encoding, which involves screening relevant from irrelevant information, selective combination, which involves putting together the relevant information in a coherent and organized way; and selective comparison, which involves relating old, previously known information to new, about to be learned information.

3. An educational taxonomy: Bloom (1956). Bloom has proposed a hierarchical taxonomy for cognitive information processing. At the lowest level is knowledge. The next level if comprehension, which requires one to go beyond knowledge in that one must understand what one comes to know. At the next level is application, which is a level higher yet in that the individual must also be able to apply what he or she has comprehended. A level higher up is analysis, which requires one critically to appraise what one comprehends and applies. Still higher is synthesis, which requires putting together in a somewhat creative way the knowledge one has analyzed in various domains. At the highest level is evaluation, which is a broad and critical appraisal of the knowledge one has analyzed and synthesized.

In this section, I have described three taxonomies of critical thinking skills. Although the organizations of these taxonomies are different, as are the exact thinking skills they comprise, the overlap among the taxonomies is striking. All of the theorists cited believe in the importance of learning, comprehension, deductive reasoning, and inductive reasoning skills. The names they give to the various skills within each of these domains differ, but the skills seem to differ hardly at all, except with respect to how finely differentiated and how broadly

encompassing they are within one or another theory. Thus, it appears that there may be a certain core of critical thinking skills that would appear in any reasonably complete list. In fact, Joan Gubbins of the Connecticut State Department of Education has surveyed a large number of similar taxonomies, and has developed a list that reflects the skills listed by numerous theorists. Table 1 contains the various thinking skills in Gubbins's (1985) list.

Insert Table 1 about here

The relation of critical thinking to the experience of the individual. It is one thing to apply critical thinking to tasks and situations that are familiar to us, but quite another to apply it to tasks and situations that are unfamiliar. Often, the processes and strategies that come so easily to us in familiar situations simply resist implementation in strange tasks and situations. The processes and strategies may or may not be different in the novel task or situation. Sometimes, it is their readiness for implementation that differs between familiar and unfamiliar situations. Again, consider three alternative but related views of the role of novel experience in critical thinking.

1. A philosophical view: Paul (in press). According to the philosopher, Richard Paul, an essential element of critical thinking--perhaps the essential element--is the ability to see things from others' points of view, which may be quiet novel and even foreign with respect to one's own point of view. Paul refers to such thinking as dialogical. For example, the ability of a liberal to see things from a conservative point of view, the ability of a husband to take his wife's

point of view on the desirability of sharing housework, and the ability of an adult to see things through a child's eyes, are all examples of dialogical thinking. Such thinking is necessary to escape the egocentrism and narrowness of perspective that characterizes the "unilogical" thinking in which most of us so often indulge.

2. A psychological view: Sternberg (1985). In my own, experiential account of critical thinking, the importance of coping with novelty is strongly emphasized. There is good reason for this emphasis: It is often in the novel task or situation--such as the Bay of Pigs or the Watergate crisis mentioned earlier--that the potentials for either great gain or serious loss present themselves. Indeed, the great contributions to the world are often traceable to major insights in which an ingenious individual has seen a new and useful way to solving a problem, whether a new one or an old one.

According to Sternberg and Davidson (1983) (see also Davidson & Sternberg, 1984), insight is an important part of the ability to deal with novelty. We propose that insights are of three kinds--selective encoding, selective combination, and selective comparison, as discussed earlier. Thus, the processes of insight do not differ from the process of knowledge acquisition in more ordinary critical thinking. What does differ, however, is the knowledge base to which these processes can be brought to bear. In ordinary thinking, we have a set of clues or guidelines or rules we can use to help us learn new things. In insightful thinking, we do not have such a readily-available set of clues, guidelines, or rules. We must make up the rules as we go along, and it is in this sense that an insight is a leap into the unknown: It is a leap not only in knowledge, but in the way in which that knowledge is acquired.

3. An educational view: DeBono (1967, 1969). DeBono has proposed a series of techniques for enhancing people's critical thinking. One of the most well-known of these is what he refers to as PMI: plus, minus, interesting. What, exactly, does this mean?

Consider a series of alternative solutions to a given problem, for example, what we would do if all money in the world instantly became worthless. (DeBono's interest in developing the ability of his readers and listeners to deal with novelty can be seen right away in his choice of problems, many of which are themselves highly novel, as is this one.) DeBono suggests that as each alternative solution to a complex problem is posed, one should list the positive (plus), negative (minus), and interesting features of that solution. DeBono's view is unusual for its stress on the evaluation of the interest as well as the positive and negative features of each solution. Getting people to think in this way encourages them to develop their ability to see both familiar and unfamiliar problems in novel and potentially interesting ways.

Once again, underlying the differences in language, there appears to be a common core of beliefs regarding the nature of the ability to deal with novelty. Insights almost inevitably involve some degree of dialogical thinking. They require us to perceive a problem we may have been pondering for quite some time from a new and different perspective. Most of the classical insight problems, such as the "nine-dot" problem, require us to see a given problem from a new and seemingly unusual vantage point. In the nine-dot problem, for example, one must connect nine dots arranged in a 3 x 3 matrix with no more than four pencil lines, without ever lifting one's pencil from the paper. Solution of the problem requires one to recognize that one must go outside the implicit perimeter

defined by the dots in order to be able to connect them. Similarly, truly insightful thoughts are generally interesting thoughts, even if the insights turn out to be wrong. Indeed, encouraging people to think in "interesting" ways may be tantamount to encouraging them to think more insightfully. Thus, whatever the language the various theorists use, their conception of the role of novelty in critical thinking seems to be highly similar, although certainly not identical.

The relation of critical thinking to the external world of the individual. Perhaps the single question that most directly motivates this section of the article is: critical thinking for what? If innumerable studies of transfer of training have revealed anything, it is that transfer is exceedingly difficult to attain. Teaching thinking skills or any other skills in any one context does not assure or even render likely, their transfer to another context. Moreover, it is not even immediately obvious that critical-thinking skills are the same in all situations. Certainly, their instantiations differ. It is necessary that critical thinking skills be taught in a way that maximizes the probability of their transfer to real-life situations. This necessity has been recognized in different ways by different theorists.

1. A philosophical approach: Lipman (1974). Lipman's program for training thinking skills, Philosophy for Children, presents these skills in the context of the everyday lives of children (see Lipman & Sharp, 1975; Lipman, Sharp, & Oscanyan, 1977). The basic format of the program has students reading novels about children in their everyday worlds, and about how they bring critical thinking to bear upon these everyday worlds. Students are not left to figure out how to bridge the gap between critical thinking skills and everyday life. Rather, in all phases of the

program, they are provided with explicit models (the protagonists in the novels, who are themselves children) of how this bridging can be done.

2. Two psychological approaches: Bransford (1984) and Sternberg (1985). In Bransford's book on the "ideal" problem solver, almost all of the techniques presented are demonstrated through everyday examples. The techniques for problem solving are "brought to life" through concrete instances, and readers are encouraged immediately to apply the techniques to problems they face in their own lives.

Sternberg (1985) takes a somewhat different approach, initially illustrating methods of critical thinking through concrete examples, but then providing exercises that range from the academic to the practical. The idea motivating this variation in types of context is that students will best learn how to apply processes and strategies of critical thinking in their everyday lives if they use these processes and strategies in the broadest possible array of circumstances, ranging from the most academic to the most practical.

Both Bransford's and Sternberg's approaches contrast with the approach of Feuerstein (1980), in which problems (or "instruments," as Feuerstein calls them) are largely academic and abstract in nature. Feuerstein calls for bridging of cognitive skills to students' everyday lives, but this bridging is pretty much left to the teacher, and thus is less controlled in terms of how and how much it occurs. From the present point of view, this deemphasis upon the external world of the individual in the training would tend to have less favorable implications for transfer than would the greater emphasis of other programs.

3. An educational approach: Head Start. Perhaps the best example of educational philosophy for bridging the gap between thinking skills and the real world was embodied in the numerous Head Start programs of the 1960s, some of which continue in modified form to the present day. There was no one consistent philosophy or even psychological theory behind these programs. Many programs seem to have had no particular philosophical or theoretical underpinnings at all. What the programs did have was a commitment on the part of their initiators to making a difference in children's lives, and particularly, in their schooling. However one evaluates the outcomes of these programs, one would have to give them credit for bringing educators and laypeople to the realization that intellectual skills are potentially trainable. These programs were transitional between nothing, on the one hand, and the theory-based programs of today, on the other.

Tests for Measuring Critical Thinking

Several tests have been advanced that purport to measure critical-thinking skills. The tests overlap to a large degree in the skills they measure. Nevertheless, there are some differences worthy of note. The purpose of this section is not to provide an exhaustive review of all of the available tests, but rather to illustrate some of the basic principles underlying these tests, and how they relate across the range of tests available. The emphasis will be upon tests at the secondary-school level.

1. Three philosophically-derived tests: the Watson-Glaser Critical Thinking Appraisal, the Cornell Critical Thinking Test, and the New Jersey Test of Reasoning Skills. All three of these tests are derived from the philosophical tradition of measuring critical thinking. They are highly overlapping conceptually.

The Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980) contains five subtests, each measuring a somewhat different critical-thinking skill. There are two forms of the test, each containing a total of 80 items. Untimed administration is recommended, although an optimal time limit of 40 minutes can be imposed (in which case subtest scores will be less interpretable, as timing is for the test as a whole and subjects may not complete later subtests). The test is suitable for individuals at the Grade 9 level and above.

The five subtests are (a) Inference, which requires discrimination among degrees of validity of inferences drawn from given data; (b) Recognition of Assumptions, which requires recognition of assertions; (c) Deduction, which requires determination of given statements of premises; (d) Interpretation, which involves weighing of evidence and deciding if generalizations or conclusions based on the given data are warranted; and (e) Evaluation of Arguments, which requires distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question at issue. The actual test items have high face validity, in that they draw upon classroom and general life situations.

Various norms are available, including high school norms (by grade), norms for various college and university groups, and various occupational norms. The main kind of score is the percentile equivalent to a given raw score. Split-half reliability coefficients for various groups generally range in the .70's for the test or a whole. Correlations with intelligence tests are variable, but seem to center at about the .6 level with verbally-weighted tests. It is not clear whether the test has incremental validity in predicting various kinds of performances beyond that which would be obtained with a student group intelligence test.

The Cornell Critical Thinking Test (Ennis & Millman, 1971) is based upon Ennis's conception of critical thinking, as briefly described earlier. The test is available in two levels, X and Z. Level X is appropriate for secondary school (grade 7) and beyond, Level Z primarily for college students (and bright secondary-school students). Level X has 71 questions and a time limit of 50 minutes. Level Z has 52 questions, but the same time limit as Level X.

Level X contains four sections. The first section contains items asking for the bearing, if any, of information on an hypothesis. The hypothesis is in every case a general statement. Examinees must indicate whether a particular hypothesis is warranted by the data. The second section is concerned with measuring examinees' ability to judge the reliability of information on the basis of its source and the conditions under which it is obtained. The third section measures students' ability to judge whether a statement follows from its premises, and the fourth section involves identification of assumptions.

Level Z contains seven sections, measuring the examinees's ability to (a) indicate whether a statement follows from its premises, (b) detect equivocal arguments, (c) evaluate reliability of observations and authenticity of sources, (d) judge the direction of support, if any, for a given hypothesis, (e) focus on choosing of useful predictions for hypothesis testing, (f) define terms, and (g) spot gaps in arguments.

Norms for both levels of the Cornell Critical Thinking Test are given as percentile equivalents. Internal consistency reliabilities for various groups appear to center around .8 for Level X, and around .7 for Level ZZ. Correlations with other tests are variable. They seem to center around .5 for verbally oriented intelligence tests. The reported correlation with

the Watson-Glaser, .48, is no higher than the correlation of the test with verbal IQ and scholastic aptitude measures, and the correlation of the Cornell with the ACE Test of Critical Thinking, .44, is also no better than the correlation of the Cornell with the Watson-Glaser. These data are not auspicious in indicating a clear, differentiable construct of "critical thinking" apart from general verbal intelligence.

The third of the philosophically-based tests to be described here is the New Jersey Test of Reasoning Skills, Form B, developed by Virginia Shipman (1983) of the Educational Testing Service and promoted in conjunction with Lipman's Philosophy for Children program. The New Jersey Test of Reasoning Skills is a 50-item inventory purporting to measure 22 different skill areas: converting statements, translating into logical form, inclusion/exclusion, recognizing improper questions, avoiding jumping to conclusions, analogical reasoning, detecting underlying assumptions, eliminating alternatives, inductive reasoning, reasoning with relationships, detecting ambiguities, discerning causal relationships, identifying good reasons, recognizing symmetrical relationships, categorical syllogistic reasoning, distinguishing differences of kind and degree, recognizing transitive relationships, recognizing dubious authority, reasoning with 4-possibilities matrices, contradicting statements, whole-part and part-whole reasoning, and conditional syllogistic reasoning. Like the other tests, this one is highly verbal. Its reliabilities are reported to be in the mid-to-high- .80`s, and it is reported to correlate at the .6 to .8 level with subtests of the New Jersey College Basic Skills Placement Test, which is a test verbal and mathematical skills emphasizing achievement at least as much as aptitude. The fact that the New Jersey Test of Reasoning Skills correlates at the .8

level with the "Reading Comprehension" and "Sentence Sense" subtests of the placement test might be seen by some as slightly disturbing: All three of the tests described so far are highly verbally loaded, and one might well wonder as to the extent that what they measure is separable from general verbal skills. Indeed, the little evidence accumulated so far does not indicate a clear separation at all, perhaps because a fairly high level of verbal comprehension is prerequisite for high scores on all of these tests.

2. A psychologically-derived test: The Triarchic Test of Intellectual Skills. This test is new, is currently available in two forms only from the author (Sternberg), and is not yet normed. The triarchic test is based upon Sternberg's (1985) triarchic theory of intelligence, and hence does not purport to separate critical thinking from intelligence. The test is appropriate for high school and college levels. The twelve untimed subtests of the triarchic test are equally divided between verbal and nonverbal content, and measure (a) metacomponential thinking skills (planning, monitoring, evaluating), (b) performance-componential skills (inferring relations, applying relations, mapping higher order relations between domains), (c) knowledge acquisition componential skills (learning concepts in natural contexts), (d) ability to deal with novelty (distinguishing relevant from irrelevant information, combining relevant information in a logical way, bringing previously-acquired knowledge to bear upon the acquisition and understanding of new knowledge), (e) automatization of information processing (making conscious and controlled processing, subconscious and automatized), and (f) adaptive flexibility (bringing the various kinds of skills described above to bear upon everyday adaptation, as in

route-planning and evaluating inferential fallacies in everyday reasoning). No normative, reliability, or validity information are yet available.

To conclude, several tests are available for measuring critical thinking skills. The philosophically-based ones are highly verbally loaded, but measure reasoning in the verbal context rather than straight knowledge or fact comprehension. The distinguishability of their scores from verbal intelligence is marginal. The psychologically-based test contains both verbal and nonverbal test items. No attempt is made in this test to distinguish between critical-thinking and intellectual skills. All of the tests provide means for assessing reasoning without heavy demands upon students' knowledge base.

Programs for Training Critical Thinking

Programs for training critical thinking skills have been with us for thousands of years, although they have not always been recognized as such. The traditional name for such programs has been "logic," and at the college level, such courses have usually been taught in philosophy departments. A complete review of programs for training critical-thinking skills would obviously be beyond the bounds of this article (but see Nickerson, Perkins, & Smith, in press; Wagner & Sternberg, 1984). Nevertheless, it is possible to say something about the range of such programs. The emphasis here will again be at the secondary level.

1. <u>A philosophically-based program: Copi (1978)</u>. At the secondary-college level, courses in logic have traditionally served the function of developing students' critical-thinking skills. Texts on logic remain among the best of the philosophically-based programs for secondary and college students. One of the most well-known such texts is Copi (1978), which has gone through five editions.

Copi's course consists of three basic parts: use of language in logic, deduction, and induction. The part on language in turn consists of four chapters: (1) an opening, introductory chapter on the nature of logic, (2) uses of language in logical thinking, (3) informal fallacies, and (4) definition. The part on deduction consists of six chapters: (5) categorical propositions (e.g., the nature of "all" and "some" statements and the use of affirmation and negation in logic, (6) categorical syllogisms (i.e., combination of categorical statements into full-fledged logical reasoning problems, such as "All men are mortals. Some mortals are human. Can one be assured that all men are human?", (7) arguments in ordinary language, (8) symbolic logic (i.e., deductive reasoning when symbols rather than ordinary-language statements are used as premises and conclusions, (9) methods of deduction, and (10) quantification theory (i.e., full-fledged logical proof). The part on induction consists of four chapters: (11) analogy and probable inference, (12) causal arguments, (13) philosophy of science and hypothesis testing, and (14) probability theory.

Copi's course is fairly typical of logic texts as vehicles for teaching critical thinking. There is really no substitute for logic courses, in that none of the other kinds of courses provide the full power of the philosophical discipline for the understanding and analysis of logical arguments. At the same time, logic courses do not provide full training in critical thinking. For one think, they tend to deal only with problems and situations where the methods of logic directly apply. Yet, any problem solver quickly learns that many of life's problems do not lend themselves to formal logical analysis. For another thing, the problems they present tend to be much more structural than many of the problems

people typically encounter. Moreover, logic courses fail fully to take into account the performance limitations on human competence. (e.g., memory capacity or time or priorities for problem solving). Psychologically-based courses on critical thinking try to go beyond straightforward logic courses to deal with some of these problems.

2. Psychologically-based programs: Bransford and Stein (1984) and Sternberg (1986). Many programs based upon psychological theories or principles have been proposed. Two of the most recent such courses are those of Bransford and Stein (1984) and of Sternberg (1986).

Bransford and Stein's course is called The Ideal Problem Solver, where IDEAL is an acronym for five steps in what Bransford and Stein seem to perceive as ideal problem solving: Identifying the problem, Defining and representing the problem, Exploring possible strategies, Acting on the strategies, Looking back and evaluating the effects of one's activities.

The course is presented in a brief (150-page) paperback book containing 8 chapters, plus appendices, answers to exercises, and indices. The chapters cover (1) the importance of problem solving, (2) the model for improving problem solving, (3) improving memory skills, (4) learning with understanding, (5) intelligent criticism, (6) creativity,(7) effective communication, and (8) concluding remarks. The program is impressive for its lucidity, breadth, brevity, effective use of concrete examples, and connection to psychological theory and research. If the course has a weakness, it is perhaps in the limited coverage possible in a very brief text. This is a weakness only if one is seeking an in-depth course in critical thinking rather than a concise guide, which the IDEAL book certainly provides.

Sternberg's (1986) Understanding and Increasing Intelligence draws even more heavily upon psychological theory than does the IDEAL program. In the case of Sternberg's program, the theory is his own triarchic theory of human intelligence (Sternberg, 1985). The organization of the book and teachers' guide are shown in Table 2. This program is larger in scope than is Bransford and Stein's. It is intended to serve as a year-long, or minimally, semester-long course. Moreover, whereas the IDEAL course is designed primarily for individual reading by individual people, the Sternberg course is designed such that reading of the text (which can stand on its own) is ideally supplemented by class discussion, papers, supplementary activities, and the like.

Insert Table 2 about here

Sternberg's program is based upon several key instructional principles.

First, one must teach for transfer, rather than merely hoping it will occur. The program does so by including problems that range from academic to practical, that range widely in content (e.g., mathematics, logic, reading, science, social studies), that range from familiar to unfamiliar, and that range from abstract to quite concrete. The idea is to instantiate the basic processes of the triarchic theory in as broad a range of problem types as possible.

Second, the program emphasizes motivating both students and teachers. A key motivational device is teaching the students and teachers about the theory and how it serves as a useful basis for a program to train intellectual skills.

Third, the program emphasizes training of metacomponents (executive processes) as well as performance components and knowledge-acquisition components (non-executive processes), as well as their application to novel and real-world situations. Thus, the instruction covers the full range of stipulations of the underlying psychological theory.

Finally, the program has an entire chapter on emotional and motivational blocks to the utilization of one's intelligence. These blocks include dispositions such as fear of failure, lack of follow-through, task completion difficulties, misattribution of blame for failure, and the like. The goal of this chapter is to make students aware of the impediments that often prevent them from making the most of whatever intellectual skills they have.

3. An educationally-based program: Whimbey & Lochhead (1982). Problem Solving and Comprehension (third edition), a course at the high school-college level prepared by Arthur Whimbey and Jack Lochhead, is fairly typical of educationally-based programs for training critical-thinking skills. It can be used as a main text or as a supplementary text on courses on critical thinking. The book contains 11 chapters plus appendices: (1) test your mind, (2) errors in reasoning, (3) problem-solving methods, (4) verbal reasoning problems, (5) six myths about reading, (6) analogies, (7) writing relationship sentences, (8) how to form analogies, (9) analysis of trends and patterns, (10) solving mathematical word problems, and (11) the "post-wasi test." There is no particular psychological theory underlying the program, and the order of the chapters seems to be somewhat arbitrary. Problems tend to be fairly academic, and no specific provisions appear to be built into the program to encourage transfer. Primarily, what students get is a lot of practice

in problem solving, and fairly minimal instruction in general techniques of problem solving. The course does not contain the fairly elaborate motivational aids of the two courses discussed above, nor does it contain many real-world problems.

Conclusions

I have presented in this article a brief overview of some of the main issues in the study of critical thinking: its nature, its measurement, and its improvement. Although there is still a long way to go, we have come remarkably far during the last few years in advancing our understanding of critical thinking. We have some good ideas both about how to test it and how to train it. At the same time, we need to recognize some of the limitations on our present understanding.

First, we have a much better understanding of analytical (critical) thinking than we do of synthetic (creative) thinking. This imbalance in our understanding is not for a lack of attempts to understand creative thinking (see e.g., Amabile, 1983; Perkins, 1981). Rather, creative thinking seems to be much more resistant to analysis. Yet, the most important contributions of thinking to the world and its cultures are probably in the synthetic domain rather than in the analytic one.

Second, existing tests seem only to scratch the surface of critical thinking, and to do that even in flawed ways. We have seen how many existing tests tend to be highly "verbally loaded," and indeed, what these tests measure is not clearly distinguishable from verbal intelligence as it is traditionally operationalized in standard tests of intelligence. Moreover, there is a large gap between the ability to apply critical thinking in fairly trivial, highly structured, and usually multiple-choice tests, on the one hand, and in one's everyday life, on the other. None of the tests came even close to bridging this gap.

Third, our training programs for improving critical thinking are themselves in need of improvement (see Sternberg, in press, for a critique of these programs). The programs, like the tests, do not fully bridge the gap between the classroom situation and situations outside it. Moreover, with few exceptions, the programs tend to be fairly narrow both in the range of skills they cover and in the instantiations within which these skills are instantiated.

The current concern of educators with critical thinking offers students a new chance for developing critical-thinking skills. This chance will come to nought, however, if the concern proves to be nothing more than a brief infatuation, if training in critical thinking is not brought into all aspects of classroom endeavor, or if the concern stays only a concern and is not followed through with large-scale interventions. Training in critical-thinking should not be the privilege of a selected intellectual minority, or the luxury of the upper-class. It should be the right of every student, and it is our responsibility to all our students to enable them to exercise this right.

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Table 1

Gubbins's (1985) Matrix of Thinking Skills[a]

I. Problem Solving

- A. Identifying general problem
- B. Clarifying problem
- C. Formulating hypothesis
- D. Formulating appropriate questions
- E. Generating related ideas
- F. Formulating alternative solutions
- G. Choosing best solution
- H. Applying the solution
- I. Monitoring acceptance of the solution
- J. Drawing conclusions

II. Decision Making

- A. Stating desired goal/condition
- B. Stating obstacles to goal/condition
- C. Identifying alternatives
- D. Examining alternatives
- E. Ranking alternatives
- F. Choosing best alternative
- G. Evaluating actions

III. Inferences

- A. Inductive thinking skills
  - 1. Determining cause and effect
  - 2. Analyzing open-ended problems
  - 3. Reasoning by analogy

4. Making inferences
5. Determining relevant information
6. Recognizing relationships
7. Solving insight problems

B. Deductive thinking skills
1. Using logic
2. Spotting contradictory statements
3. Analyzing syllogisms
4. Solving spatial problems

IV. Divergent Thinking Skills
A. Listing attributes of objects/situation
B. Generating multiple ideas (fluency)
C. Generating different ideas (flexibility)
D. Generating unique ideas (originality)
E. Generating detailed ideas (elaboration)
F. Synthesizing information

V. Evaluative Thinking Skills
A. Distinguishing between facts and opinions
B. Judging credibility of a source
C. Observing and judging observation reports
D. Identifying central issues and problems
E. Recognizing underlying assumptions
F. Detecting bias, stereotypes, cliches
G. Recognizing loaded language
H. Evaluating hypotheses
I. Classifying data
J. Predicting consequences

K. Demonstrating sequential synthesis of information

L. Planning alternative strategies

M. Recognizing inconsistencies in information

N. Identifying stated and unstated reasons

O. Comparing similarities and differences

P. Evaluating arguments

VI. Philosophy and Reasoning

A. Using dialogical/dialectical approaches

[a]This matrix is based upon a compilation and distillation of ideas from Bloom, Bransford, Bruner, Carpenter, Dewey, Ennis, Feuerstein, Jones, Kurfman, Kurfman & Solomon, Lipman, Orlandi, Parnes, Paul, Perkins, Renzulli, Sternberg, Suchman, Taba, Torrance, Upton, the Ross Test, the Whimbey Analytical Skills Test, the Cornell Critical Thinking Test, the Cognitive Abilities Test, the Watson-Glaser Critical Thinking Appraisal, the New Jersey Test of Reasoning Skills, and the SEA Test.

Table 2

Organization of Understanding and Increasing your Intelligence: A Triarchic Program for Training Intellectual Skills by Robert J. Sternberg

Students' Text

Part I. Background

Chapter 1: Some Historical Background on Views of Intelligence and Attempts to Increase It

Chapter 2: The Triarchic Theory of Human Intelligence

Part II. The Internal World of the Individual: Components of Human Intelligence

Chapter 3: Metacomponents (Executive processes used to plan, monitor, and evaluate problem-solving performance)

Chapter 4: Performance Components (Nonexecutive processes used to execute the instructions of metacomponents)

Chapter 5: Knowledge-Acquisition Components (Nonexecutive processes used to learn how to solve problems)

Part III. The Experience of the Individual: Facets of Human Intelligence

Chapter 6: Coping with Novelty

Chapter 7: Automatizing Information Processing

Part IV. The External World of the Individual: Functions of Human Intelligence

Chapter 8: Practical Intelligence

Part V. Personality, Motivation, and Intelligence

Chapter 9: Why Intelligent People Fail (Too Often)

Instructor's Manual

1. Purpose of Chapter
2. Chapter Outline
3. Main Ideas
4. Questions for Class Discussion
5. Suggested Paper Topics
6. Supplementary Activities
7. Suggested Readings
8. Suggested Time Allocation